ATTENTION: EXPERIMENTAL AND CRITICAL.

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OUTLINE. I. Some slight additions to the reported experiments on Attention. II. A brief historical sketch of the subject. III. The writer's views. IV. A summary of by-products of the experiments which suggested, and in turn get meaning from, the view held. V. Bibliography.

I.

At the outset there will be no attempt made to define Attention; the word will be used in its ordinary sense. The experiments to be described, and which were performed in the laboratory of Clark University, fall into three general groups. In the first, use was made of perception, association and reaction time; in the second, perception and association; in the third, perception only. In these groups the question set was always: What differences, if any, can be found in the results of a given task performed on one occasion with concentration, at another with distraction of attention?

A. REACTION-TIME.

This series, carried on in the winter of 1893-4 and fall of 1894, aimed to combine tasks of various degrees of difficulty with distraction of various degrees of effectiveness. Its object was to arrange a series of tasks of increasing degrees of complexity which should make ever greater demands on the mind, until attention should pass from a fully concentrated to a completely distracted state. The work was begun in full sympathy with Wundt's position, and, indeed, was understood as but a mere continuation of the course begun by him and others.[1] The experiments with five subjects[2] were as follows:

I. Multiplication table up to 12×12, factors given in four sets of eighteen couplets each, in hour sittings, first and last sets with concentrated attention and signals; second and third without signals and with distraction. The distraction consisted of: reading text (1) silently, (2) aloud; naming letters (1) in direct order in text, (2) in reverse order, (3) on drum, seen one at a time; fixation of one letter seen through a slit. Further work was given also in multiplication, *e. g.*, 6×19, etc. The factors were given (1) orally, circuit closed with last factor, (2) by Fall-apparatus. Reading, for purpose of distraction, was (1) stopped when last factor was given, (2) continued until after answer was got. Reactions made by finger key and with mouth key; to be made in shortest possible time.

II. Stimuli—(a) by *Fall-apparat:* (1) letters, (2) colors, (3) diagrams, *e. g.*, crescent, star, circle, triangle, cross, (4) factors to be multiplied, (5) numbers from one to ten; (b) oral: factors and

[1] Phys. Psych., 4th ed., Vol. II. Chap. XVI, and *Mind*, Jan., 1895, p. 79.

[2] Besides the writer these were Dr. E. C. Sanford, Mr. A. H. Yoder, Mr. A. C. Ellis and Mr. J. R. Slonaker. To these gentlemen I am greatly indebted for many months of careful work.

numbers as in (4) and (5). Reactions made on five and ten-fingered keyboards were semi-adaptive, or with from one to all the fingers of one or of both hands. Stimuli were given in four sets: first and last with free attention and ready signal; second and third with distraction and no signal.

The times were taken chiefly by the Hipp chronoscope, though other methods were used. The figures obtained are regarded as unsatisfactory, though in passing it should be said they are in substantial agreement with those obtained by other experimenters working under like conditions. Greater stress is laid on the observations made during the course of the experiments on external and introspective accompaniments; rather full notes kept of these will be given in connection with similar data got while carrying out other lines of experiments.

B. Association Experiments.

Association experiments were performed in spring of 1894, to find in what degree, if any, the process and variety of strictly relevant associations are affected by concentration and distraction of attention. The material consisted of four sets of cards prepared for me, 100 in each, on which were written words, grouped as follows:

	I.	II.	III.	IV.
Common nouns,	64	57	57	66
Proper nouns,	2	4	2	6
Nouns or verbs,	21	24	34	22
Abstract nouns,	8	8	7	5
Adjectives or nouns,	4	6	0	0
Adjectives,	1	1	0	1

Each set was taken twice, with an interval of a month; the results of each first trial were not looked at nor thought about during the interval. Tables A and D show the order in which the sets were taken and repeated. Distraction was got by adding columns of logarithmic tables; five groups of these—vertical,—with five figures in each group, were taken as a stint; the plan followed was to add the first group, and while passing up to the next, to glance at the card, catch the word, and go on with the addition. The figures were at my right, the pack of cards at my left, and not to be seen save by special effort; the figures were covered either by thumb or by a card held in left hand, and were exposed singly. With concentrated attention the time allowed (fifteen seconds) was kept by a clock striking quarter-minutes. (Cf. Bergström, American Journal Psychology, Vol. VI, p. 248.) In this portion of the work the cards were on the table before me, hid by a block. As the clock was about to strike, I leaned forward with eyes on wall, and dropped them on the word at the stroke. All unrelated "associations" were ruled out, inhibited at once. At times this practice worked against the reception of some rightful though unrecognized claimants, and these, now and then, continued to press their claims until admitted, though often they were seen aright too late to be included within the time limit. After each trial the associations were jotted down, and then dropped from mind as quickly as possible. Work was usually done in hour shifts in the morning. Average time per word (inclusive of time taken to write out the associations, etc.) was with concentrated attention, 2.2 minutes; with distracted, 2.4 minutes. The latter is a little greater, but it includes the time taken to check the additions.

Because of differences in method it is impossible to make a sta-

tistical comparison with Galton's work,[1] but it may be well to call attention to the fact that Galton selected his words, and thus began with a set of associations; repetition of these would but fix them deeper. It is probable, too, that a large part of his list were suggested by matters new in his mind. As did Galton, so do we find any attempt at classification of one's mental furniture sure to be unsatisfactory. Eye, ear, and motor-mindedness may be convenient groupings in a discussion, but are inseparable in the mind. The conditions of the experiments were such as to cause a strong bias to internal speech. The words used were repeated mentally, and the process of association was with us begun often before the object for which the word stood was fairly realized; often not the object itself was got, but instead a strong sense of its location and place associates. Mere verbalisms, puns, catch phrases and the like were frequent; irrelevant pseudo-associations, *i. e.*, associations of associates, were a pest difficult to escape. It was less easy to pick out those cases wherein the eye was caught and associations suggested which were not strictly pertinent; by eye were often recalled derivatives of the root whence the keyword came,—though one could not be sure the associates did not join directly to the root-meaning. Visualization was common; localization was seldom absent. Results are as follows:

TABLE A. NUMBER AND DISTRIBUTION OF ASSOCIATIONS.

	1		2		3		4		Sum of α(1-4) a	Sum of β(1-4)a	Sum of β(1-4)b
	a	b	a	b	a	b	a	b			
I. α. Distracted Att.	116		130		74		17		337		
β. " "	52	49	87	61	44	36	15	6		198	152
	168		217		118		32				
II. α. Concentrated Att.	120		185		108		10		423		
β. " "	43	66	92	80	40	37	16	3		191	186
	163		277		148		26				
III. α. Distracted Att.	147		166		74		7		394		
β. Concentrated Att.	70	93	86	95	50	42	26	2		232	232
	217		252		124		33				
IV. α. Concentrated Att.	138		162		83		6		389		
β. Distracted "	41	89	80	92	43	36	22	5		186	222
	179		242		126		28				

1, First two-fifths of life; 2, second two-fifths; 3, last fifth, save 4, the immediate past.
a. New associations in first and second trials; b, repeats.

[1] Cf. Bibliography at end.

TABLE B. DISTRIBUTION OF ASSOCIATIONS WITH CONCENTRATION AND DISTRACTION.

	1	2	3	4	Sum	
Concentrated Attention,	371	525	281	58	1235	52.55%
Distracted Attention,	356	463	235	61	1115	47.45%
	727	988	516	119	2350	100.00%
Repeats,	297	328	151	16	792	

Table B is derived from Table A; *e. g.*, from column 1 a, 120+43+70+138 = 371; etc.

TABLE C. DISTRIBUTION BY PER CENTS.

Of the 2,350 new associations

		Concentrated.	Distracted,
30.93%	Come under 1,	15.78%	15.15%
42.04%	Come under 2,	22.34%	19.70%
21.96%	Come under 3,	11.96%	10.00%
5.07%	Come under 4,	2.47%	2.60%
100.00%		52.55%	47.45%

TABLE D. NEW ASSOCIATIONS ON SECOND TRIAL.

I. Distraction, followed by same,	337	62.99%
	198	37.01%
	535	100.00%
II. Concentration, followed by same,	423	68.89%
	191	31.11%
	614	100.00%
III. Distraction, followed by Concentration,	394	62.94%
	232	37.06%
	626	100.00%
IV. Concentration, followed by Distraction,	389	67.65%
	186	32.35%
	575	100.00%

Table D is derived from Table A, third and second columns from the right.

TABLE E. REPEATS ON SECOND TRIAL.

I. Distraction, followed by same,	337	100.00%
	152	45.10%
II. Concentration, followed by same,	423	100.00%
	186	44.00%
III. Distraction, foliowed by Concentration,	394	100.00%
	232	58.88%
IV. Concentration, followed by Distraction,	389	100.00%
	222	57.07%

Table E is derived from Table A. third and first columns from the right. Of 337 associates got on first trial, 152 recurred when the series was repeated a month later.

TABLE F. ASSOCIATIONS BY KIND; FIRST ASSOCIATIONS ONLY, NO REPEATS.

Concentrated Attention.

	Concrete.	Verb.	Story.	Word, &c.	Reason'g.	Sum.
II. 1 and 2,	230	28	153	114	81	606
III. 2,	87	13	41	58	33	232
IV. 1,	171	25	75	89	25	385
Sum,	488	66	269	261	139	1223
Percentage,	40	5.4	22.	21.3	11.4	

Distracted Attention.

I. 1 and 2,	214	19	143	93	48	517
III. 1,	175	34	83	76	23	391
IV. 2,	58	5	64	35	23	185
Sum,	447	58	290	204	94	1093
Percentage,	40.9	5.3	26.5	18.6	8.6	

Hampered by the conditions—in a limited time to get the greatest possible number of direct and good associations to a seen word,—the work was of course in some respects not normal. The number of associations got with concentrated is but little more than with distracted attention,—evidently because especial effort within the time limit was nearly equivalent to the distraction. Ranging was precluded by the conditions, though ranging is required in

order either to get new associations, or at least to dip into these when found. A comparison of sets III and IV, Table A (see especially the second column from the right, 232 against 186), indicates that to end an experiment with close attention enables one to clean up his scattered associations, though in several instances the commonest associates were not found. " Clock " gave me clocked stockings, but not a time-piece; " school " gave school of fish, and to school, *i. e.*, discipline one's-self, but not an inkling of the many schools attended or taught. In many cases it is difficult to satisfactorily assign the associations to their proper period of life. When they first occur—under the conditions of the experiment—they are most often fragments, nodes of a network, whose connections trouble either by lack or overabundance. One thing, however, is commonly well marked: that recent events are hard to remember when the stress is great. The period included under 4 was limited to a few days preceding the tests, and its incidents were sights, conversations and other such matters as are usually totally forgotten in a short time. Tables B and C show how slight, under the conditions, was the influence of attention. Of the determinants of association given by James (Vol. I, p. 577) recency and the oldest habits fall out in an examination of this sort.

Under D a comparison of I and III with II and IV, shows disturbing effect of distraction on first trials, since in I and III was got a less per cent. of the whole number of new associations than in II and IV. Yet an examination of the results of the second trials of the same sets shows no marked differences due to conditions of attention. In Table E, comparison of repeated associations, the most striking feature is the marked uniformity of the repeat-percentages under like requirements. The increase in the number of repeats shown in A and E, probably indicates growth in ease and habituation in performing the experiments, though it should be said that in the earlier part of the work, repeats, which returned with force, were turned down as unprofitable material, and greater effort was made to hold close to the key-word. As the work grew more familiar, the repeats were recognized, noted and passed with little trouble, and thus more of them found place in the final reckoning. Although the repeats were more or less bothersome, still from the start they seemed empty, persistent, yet worthless; as the work progressed they became less insistent, — mere echoes of the former trials. As the mind became adjusted to the conditions, the ideas which gathered about the key-word tended to form groups and to return *en bloc*. As for the addition, it soon ceased to be much of a distraction, in the sense of a source of flurry,—although when series of like or of small numbers occurred they proved to be very confusing. Accustomed to an irregular gait, both in the compulsory hunt for associates and in the addition of unlike numbers, the mind could only with great difficulty curb itself for a uniform series. Series such as 4-3-2-1-0, 2-2-2-2, or 5-1-5-1, would almost inevitably cause a break in the work. In fact the attempt to do orderly, *i. e.*, continuous, work was more distracting than the distraction, — true, of course, only because the conditions were such as to make the work an alternating one. Whether the alternation was from word to figure or from an associate back to the key-word (for it was required that each associate should be connected with the given cue), in either case irradiation, or growth of an idea, was hindered. Some words that suggested few associates occasioned slow diffusion about a centre (where the mind stuck), either through attempts at derivation, or by more or less

confused lines of reasoning. But these efforts tended to vagueness, whereas the conditions called for many and definite associations; and so it came about that fatigue, whereby the temptation to range was cut off, proved an aid to lessen the power of the distraction to control one's attention, and in this way permitted greater skipping.

A most striking feature of the work was the spatial setting given to almost all the associates save a few mere verbalisms. This localization was felt as a muscular tension toward the object named, which in turn needed a setting to give it the tang of reality. Almost equally necessary was the conscious inner arrangement of the associations, which had to be created into some muscle-tension form (usually a word) in order to be carried subject to recall. Words that offered little occasion for tangible (in the main visible) experience, and which for this reason had few concrete space locations, were usually confusing, *e. g.*, will, meditation. The confusion sprang from great familiarity with meanings which wanted concise muscular expressions; words with less used content, *e. g.*, continuity, plurality, were quickly placed in some book or conversation.

Refractory though the material was, a classification was made of it according to kind, as shown in Table F. The limits of these groups are as follows: Concrete, a well visualized object. Verb, some specific act suggested by the verb key-word. Story, recalled by key-word. Word, mere verbalisms, puns, proverbs, etc. Reasoning includes, in greater part, the cases of diffusion noted above. Examples are: with "nut" was associated Piñon Jay (*Gymnocitta cyanocephala*), which, though ruled out, hovered in the shadow until one of its synonyms—*nucifraga*—came up. "Enchantress" gave me *Circæa lutetiana*, the enchanter's night shade, and set my thoughts as follows: Night shade—a poison—poisons act on the body—so do Circean smiles; then came a vague notion of James' theory of emotions, and of controlling one by his emotions. The propriety of admitting this last group (reasoning) may seem questionable because its examples were not so directly referred to the key-word, yet in truth it is hard to say how many of even the verbalisms were got by a movement straight from the stimulus.[1]

C. Least Interval.

In the American Journal of Psychology, Vol. VI, is an article by Miss Alice J. Hamlin on the "Least Observable Interval between Stimuli addressed to Disparate Senses and to Different Organs of the Same Sense," wherein, pp. 572-3, are noted results of experiments with forced attention, and the conclusion "that voluntary attention is ineffective." The experiment of perceiving closely following stimuli with concentrated and distracted attention, was continued by the writer, with results as follows:

The apparatus used was composed of the pendulum circuit-breaker[2] in connection with (a) two telephones worked by the secondary circuits of sliding induction coils; (b) iron cups filled with water, into which were plunged the fore and middle fingers of each hand—shocks mediated by induction coils; (c) for a few trials a contrivance to produce a snap, when the stimuli were a shock to a hand and a snap by one ear, made as the current jumped a break. The interval for the click and also for the shock experiments was 24σ; that for the click-shock series was 31σ. In the case

[1] See also results of experiments on S. given in a note at the close of this article.
[2] American Journal Psychology, VI, p. 581.

of the former the interval was not " the least " which could have been used, but was taken because a range was desired within which attention could be manipulated; the interval used in the click-shock experiments was probably a little too short, as will be shown in another place. Our custom was to give an equal number of stimuli in R-L and L-R order, though of irregular sequence, in sets of twenty, save in the variable series, where forty made a set; each trial was preceded by a warning signal (click of a telegraph sounder) to ensure the subject's readiness. Operator and subject were in separate rooms, with only telegraphic connections.

1.

Work began with stimuli to separate organs of the same sense, in this case with clicks of medium intensity.

1. MEDIUM CLICKS.

DATE.	SUBJECT.	INDIFFERENT ATT.		DIRECTED ATTENTION.			
				Right First.		Left First.	
		R.	L.	Att. right.	Att. left.	Att. right.	A. left.
Feb. 20-Mar. 8.	S.	75-87	75-80	49-41	44-59	43-88	48-75
Feb. 20-Mar. 7.	D.	100-90	100-72	53-57	50-90	46-87	54-50

In each column the figures first given represent the number of trials, the second set represents the percentage of correct answers.

With indifferent attention appears a trend to the right in both subjects. Both subjects also show that attention lessens the number of correct answers for the attended side. Attention to the left enables S. to overcome the bias to the right shown in the indifferent set; D. shows a strong tendency to go opposite the direction of attention. These features prevailed more or less throughout the work and will be commented on later.

Although the stimuli were adjusted so as to appear equal, and were tested before each sitting, yet they were almost always modified by subjective influences; for a time we were continually stopping for tests to see if the apparent differences in intensity were due to objective causes, and in order to neutralize any unavoidable differences in the apparatus, the terminals, telephones and cups were interchanged by sets, so that stimuli, *e. g.*, to the right side, should come an equal number of times through each terminal. As this matter of intensity played so large a rôle in the formation of order-judgments, our next experiment was with alternating series of medium and faint clicks—attention indifferent, since our aim was to get the naïve bias, if any. Of each group of four sets of twenty each, one and three—medium and faint respectively—were taken by one subject, two and four, duplicates of the other pair, by the second subject. Whilst as thus coupled there was much introspection on the "faints," yet when set off in series these were treated by the subjects apart from and with no conscious reference to the louder series.

2. CLICKS: MEDIUM AND FAINT. INDIFFERENT ATTENTION.

DATE.	SUBJECT.	MEDIUM.		FAINT.	
		Right First.	Left First.	Right First.	Left First.
Mar. 6-8, and 13-23.	S.	120-83.3	120-86.6	120-75.8	120-80.8
Mar. 6-8, and 13-23.	D.	120-81.0	120-78.0	120-79.0	120-70.0

In this group there is no trace of any bias to the right in S.; in D. it remains.

Continuing the comparison of intensities, we arranged the induction coils so they could be varied at the pleasure of the operator,—though the range of variation was limited to what was noted by each subject, *when testing*, as "just observably different." The series were short, and gave results as follows:

3. VARIABLE CLICKS: INDIFFERENT ATTENTION.

DATE.	SUBJECT.	Right First.		Left First.	
		R. Loud.	L. Loud.	R. Loud.	L. Loud.
April 5-10, June 10-19.	S.	79-63	79-75	78-77	79-72
April 6-10, June 10-12.	D.	45-11	49-86	45-96	48-58

Both subjects give preference to the faints; with D. the habit is extreme.

The electric-shock stimuli were used under the same general conditions of interval and order that governed in the use of telephones; the results of the main series are as here given.

4. SHOCKS: MEDIUM.

DATE.	SUBJECT.	INDIFFERENT ATT.		DIRECTED ATTENTION.			
		R.	L.	Right First.		Left First.	
				Att. right.	Att. left.	Att. right.	A. left.
Apr. 12-May 9.	S.	200-93	200-45	103-86	97-76	97-41	103-64
Apr. 12-May 8.	D.	200-80	200-70	90-82	110-71	104-61	96-60

Note the bias to the right, especially in S. To direct attention to shocks is a very different matter than in the click series; this matter will be treated further under the introspective comments. In the same section will be noted an interesting illusion, found while we were working with crossed hands.

In order to test a lurking inference that voluntary attention did not aid, and possibly hindered, judgments of the time order, a few series were taken with "distracted attention," got by reading aloud, at a rapid rate, interesting "short stories." Each series was preceded by one of the usual kind—indifferent attention—in order to tune up our minds. The indifferent series was preceded by the customary ready signal; the stimuli of the distraction sets came unawares and at irregular intervals.

5. SHOCKS WITH DIVERTED ATTENTION:

DATE.	SUBJECT.	INDIFFERENT.		DIVERTED BY READ'G	
		R.	L.	R.	L.
May 30, and June 7-8.	S.	40-58	40-53	60-73	60-53
May 30, and June 7-8.	D.	50-64	50-60	60-75	60-61

The only effect seems to be to give the bias to the right greater play and thus to increase the whole number of correct answers on that side.

As with the clicks, so with the shocks were taken series with variable intensities. With one exception, when right led for D., both subjects went with the fainter intensity. But the series are too short to be more than suggestive.

6. SHOCKS: UNIFORM AND VARIABLE.

DATE.	SUBJECT.	UNIFORM, MEDIUM.		RIGHT FIRST.		LEFT FIRST.	
		R.	L.	R. Strong.	R. Faint.	L. Strong.	L. Faint.
June 20.	S.	20-55	20-55	20-60	20-80	20-50	20-80
June 20.	D.	20-85	20-80	20-60	20-55	20-65	20-80

2.

By means of telephone and cup, stimuli were given to disparate senses, one ear and the fore and middle fingers of one hand. The interval used was 31σ.

7. SHOCK AND CLICK.

DATE.	SUBJECT.	INDIFFERENT ATT.		DIRECTED ATTENTION.			
		Shock.	Click.	Shock First.		Click First.	
				Att. on S.	Att. on C.	Att. on C.	Att. on S.
June 13-18.	S.	100-91	100-51	94-93	106-79	94-71	106-75
June 13-18.	D.	100-98	100-19	103-76	97-99	103-38	97-85

The most prominent feature of this series is the influence of directed attention to even up the very unequal portions got with indifferent attention. The readiest explanation of the facts is that the interval between stimuli was too short to permit the mind to adequately judge the order in the indifferent set, and that in the press the stronger, *i. e.*, more expansive, shock overbalanced the click. The interference of attention aided D. in that it served to turn his judgments in the contrary—and usually correct—direction.

It may be of interest to note the inner uniformity of the various series, and to this end the following tables, 8-11 inclusive, are submitted; figures give percentage of correct answers:

8. CLICK SERIES BY HALVES.

SUBJECT.	INDIFFERENT ATT.		DIRECTED ATTENTION.			
			Right First.		Left First.	
	R.	L.	Att. Right.	Att. Left.	Att. Right.	Att. Left.
D. I.	88	72	64	92	96	38
D. II.	92	78	52	88	61	92
S. I.	100	71	53	57	86	86
S. II.	75	86	21	62	90	58

9. SHOCK SERIES BY HALVES.

SUBJECT.	INDIFFERENT ATT.		DIRECTED ATTENTION.			
			Right First.		Left First.	
	R.	L.	Att. Right.	Att. Left.	Att. Right.	Att. Left,
D. I.	75	62	87	62	60	64
D. II.	85	78	78	80	61	57
S. I.	91	57	80	78	51	67
S. II.	95	33	94	75	33	60

10. CLICK AND SHOCK SERIES BY HALVES.

SUBJECT.	INDIFFERENT ATT.		DIRECTED ATTENTION.			
			Shock First.		Click First.	
	S.	C.	Att. Shock.	Att. Click.	Att. Click.	Att. Shock.
D. I.	96	18	78	100	24	82
D. II.	100	20	74	98	51	96
S. I.	90	52	96	84	67	71
S. II.	92	50	89	75	76	80

11. SERIES BY HALVES COMPOSED OF FIRST AND SECOND TEN OF EACH SET.

SUBJECT.	SERIES.	INDIFFERENT ATT.		DIRECTED ATTENTION.	
		I.	II.	I.	II.
D.	Clicks	77	79	70	73
D.	Shocks	75	75	67	70

3.

What, now, has introspection to say as to the subjective features of the work? Foremost is the fact, for D. at least, that the order of discrimination is from whole to parts; as the stimulus is repeated it grows in complexity. Other things being equal, in each new series and in every variation of a series, the judgments came promptly at first, and with a feeling of certainty that was fairly justified. But the feeling of ease passed away as introspection burrowed and disclosed differences before unsuspected. So it was that as we worked on, introspection notes accumulated at a growing rate, and we came at times to doubt the worth of series which actually showed a good preponderance of correct answers. Despite the fluctuations, however, two chief methods of judging were used: (1) A relatively immediate, sensory way, called "alert indifference" by Miss Hamlin (p. 574), and (2) a relatively conscious and reflective way. "*Relatively*," for we were not ordinarily conscious of such forms; whenever a case got loose from its immediate sensation-feeling, and thus made its order a matter of pure judgment, it was rejected, and the stimuli were repeated. Records were kept of these repeats (which do not figure in the tables given, and which were at times many), but as yet nothing definite has come from their study. For reasons to be given later, I believe these two forms of judgment to be stages of one process; nevertheless, to introspection the former is passive, the latter has a shade of action. Of the latter there are

two well-marked kinds, *a* and *b*. Mention has been made of the subjective differences interjected into the sensations by causes and ways thus far untraced; directed attention complicates the matter, but the reference now is to the indifferent attention sets, and chiefly to the fact that the intensities of each pair of stimuli differed subjectively, fluctuating capriciously both in degree and order. For a while the struggle—in cases when judgment lagged—was between a "feeling" and a "time" order, the two kinds listed above, *a* and *b*; introspection brought out that this time order depended on the relative intensities of the stimuli, which in turn were controlled by conditions of (1) end-organ responses, (2) general body state. One form of reasoning that slowly grew clear was: The two stimuli are objectively equal; subjectively they are unequal. One is fainter, hence farther away. But it cannot be more distant in space, hence it must have preceded the other. Another line of thought was: Into a uniform state of alert indifference or expectant attention comes a stimulus which, with a clear field, seems strong. Hard after the first comes a second, which by contrast seems faint. D. found himself controlled by the former—prejudice or bias rather than course of reasoning; S., and especially several on whom side tests were made, followed in part the latter. It should be kept in mind that the sensory, *i. e.*, passive, form—when got—furnished the most satisfactory results, because so free from any perception-fringe. An extreme of this form is found in the common experiences of life when two stimuli are separated by so great an interval as to leave no chance for doubt as to their order. The same feeling of sureness of order which accompanies the perception of well separated stimuli was present now and then, sometimes relating to isolated cases, again extending to whole series; yet the subjects at times were confident of what were, in reality, faulty sets, and again doubted correct ones. The individual cases checked immediately by D. as surely correct, give results as follows: (In each couplet the first number gives the whole number of cases checked "sure;" the second number gives the per cent. of correct answers.)

12.

Indifferent Attention.	Directed Attention.	Distracted Attention.
250-82	155-79	28-93

The freer one's mind is of anticipations of the stimuli, the better are his judgments.

The sensory form, recognized as purely passive, of course was beyond our control, and to be got only by a happy combination of circumstances. But commonly it was easy to sense the things we ought not to have done, for these were willful, though well-meant, interferences with perception. To direct attention is not an easy matter when one is prone to over-much introspection. Concentration on an ear was characterized by a strain in the ear muscles, and another, with a sense of looking fixedly, about the eyes. Attention to a hand often degenerated to a stupid stare until the plan was formed to slightly raise the hand, as if "hefting" it, at the same time slightly innervating the fingers. By this means attention was known to be *in* and not merely toward the hand, and "inner" and "outer" attention were made to coincide. The state known as

alert indifferent attention is really a state of general qualitative attention (for irrelevant matters are unheeded), with a focus of concentration in the median plane. Often during a series, as fixation grew more exact, what was at first a mere point of regard became a surface like the saddle-backed "specious present." The subject felt that the slightest wavering of attention to one side the imaginary centre would cause a bias in judgment to the favored side; then the criticism spread to his head, eyes, shoulders, and even to the equal expansion of the lungs. Because of this irradiation D. continually shifted his focus, ranging from a spot on the ceiling to one on his neck-tie, and tried some series with closed eyes. S., on the contrary, clung, as a rule, to a spot on the table at which he worked. Of the whole number of trials with directed attention, D. had 69% correct to S.'s 71%.

As might be expected in this interplay of fixation strains, there was now and then a passive state when the sensory form of judging found entrance. In truth these sensory judgments may safely be taken to mark the only times when attention was really alert and neutral, and the other cases, even of those in the nominally indifferent series, belong to more or less conscious work, as characterized by tensions. D., more troubled by introspective fancies, began early the practice noted above of putting himself into varying attitudes in order thereby to get new mental states, since the latter proved more favorable to the presence of the so-called passive judgments. S., on the other hand, was not troubled greatly by introspection until well on in the work, when he, too, became conscious of what seemed determining factors in the formation of judgments. A result of the change of method in his case is shown in the following table by the difference in the percentage of correct answers:

13. TABLE TO SHOW RESULT OF A CHANGE IN METHOD OF JUDGING.

DATE.	CLICKS.		DATE.	SHOCKS.	
	Indiff. Att.	Direc. Att.	Apr. 12-May 9.	Indiff. Att.	Direc. Att.
Feb. 20-Mar. 8.	83%	66%	First half.	74%	69%
June 11-19.	61%	67%	Second half.	64%	65%

Comparison of the earlier and later click series shows the superiority of the naïve form. The shock series, which came between the two click series, aids in tracing the gradual loss of the sensory form. In the first half the indifferent sets were judged largely by the sensory form; as the work progressed it became increasingly conscious. The different series as a whole show a growth in consciousness and *pari passu* of one's unfitness to serve as subject for such experiments as the present. We knew too much to be fit, although we worked exceedingly hard toward the end; the effort, probably, was what spoiled the work.

Because of our desire to be as free from bias as possible, we refrained in our conferences from the discussion of our introspective tendencies. For this reason exact comparisons of individual series

is impossible. But inspection of the tables, especially of No. 7, shows that one effect of voluntary attention is a falling off of the number of correct answers to the side or stimulus previously favored, and generally a marked increase to the side or stimulus before at a disadvantage. The result is, in part at least, due to interference with a physiological bias, and is accompanied by a change in the method of judging. Attention, when stimuli are to same sense, decreases the probability of correct answers; when to disparate senses, increases the probability.

14. PERCENTAGE OF CORRECT RESPONSES WHEN STIMULI ARE TO

SUBJECT.	SAME SENSE.[1]						DISPARATE SENSES.					
	Indifferent Att.			Directed Attention.			Indifferent Att.			Directed Attention.		
	Right.	Left.	Av.	Right.	Left.	Av.	Click.	Shock.	Av.	Click.	Shock.	Av.
S.	95	80	82	72	62	67	51	91	71	74	82	73
D.	78	70	74	80	63	71	19	98	59	61	87	74

This table must be taken with the following, which shows the

15. NUMBER OF TIMES WHEN JUDGMENT OF ORDER

COINCIDED WITH DIRECTION OF ATTENT'N.							WAS OPPOSITE THE ATTENTION.						
Whole number cases.	Subject.	Clicks. Correct.	Shocks. Correct.	Crossed hands.[2] Correct.	Average of the three series.	Click and shock. Correct.	Subject.	Clicks. Correct.	Shocks. Correct.	Crossed hands.[2] Correct.	Average of the three series.	Click and shock. Correct.	Whole number of cases.
466	D.	56-82	205-64	69-57	66	136-88	D.	104-65	195-71	11-56	68	284-67	594
	S.	83-54	206-75			188-82	S.	77-73	194-59			210-77	

A little more than a fourth oftener, the judgments went counter to the direction of attention, though there was a slightly greater number of correct answers with than against—72% and 68% respectively. But with such results it is in place to ask, what are the results of voluntary attention? They are complex. (1) There is a general tendency to throw doubtful cases in the direction of the attention. In numbers of places the introspective note added to the subject's order-record is, "Uncertain; go with attention." (Unless there was good reason, objective or subjective, for the rejection of a trial, it was checked, even though

[1] Sum of click and of shock series.
[2] See p. 550. First number of each couplet gives the "number of times"; second number, the per cent. of correct answers.

the order-judgment was obscure; else should we never have finished a set after our critical mood was well seated.) Yet doubtful cases were little if any more prevalent in the state called "directed" than in that called "indifferent;"—as shown by Table 12, the number of "sure" answers is but three per cent. greater in the latter. The notes of S. lead him to infer that high grade, *i e.*, very well concentrated, attention, tends to draw the judgment with it; his figures are as follows, for the click-shock series only:

16.

High Grade of Attention.				Low Grade of Attention.			
Shock First.		Click First.		Shock First.		Click First.	
Att. Shock.	Att. Click.	Att. Shock.	Att. Click.	Att. Shock.	Att. Click.	Att. Shock.	Att. Click.
29-100	27-67	17-59	36-89	65-89	79-84	89-79	58-60

Yet, as has been so often said, our record was a growing one, expanded as difficulties arose; hence it does not extend alike to all the series. What we should have passed as unquestioned good attention at one time, a month later would be found seamy. D.'s record, so far as available, for cases when the attention was felt to be good and the order of judgment was with the attention, shows 93% of correct answers as against 74% correct when judgments went counter good attention. (These are from cases listed in Table 15, and are characterized by a good degree of concentration. They differ from the cases recorded in Table 12, also, in that those have reference to certainty of judgment.) At first the record seems to make good a claim that attention is an aid, but comparison with the "Distracted Attention" series—Table 12—shows another 93% got under conditions the opposite of attentive.

(2) The most marked subjective effect of directed attention, for D. at least, was the weakening of the stimuli. Ordinary attention to a stimulus is usually accompanied by an increase in the relative prominence of the latter in consciousness,—for simplicity, say its intensity; (we will leave aside any reference to, *e. g.*, dreaded danger which vanishes when bravely met). When the stimuli, clicks or shocks, were tested, preliminary to the regular series, to ensure likeness, they were easily compared and equalized. Then, as the experimenting went on, it became increasingly difficult to sense them, especially the faint ones. This loss was not due to fatigue, *i. e.*, to exhaustion of the part concerned, because a return to the test-attitude of mind revived the stimuli. That it was the result of an attention-strain seems evident from a study of the growth of the introspection notes. In the early part of the work, stops to overhaul the apparatus with the intent to find in it an objective cause for intensity-variations, were frequent; but when fairly in on the shock series, we found that to throw the attention well into a hand was equivalent to diminishing the intensity of the stimulus to that hand. Not that this result always came, for there are several comments of surprise at pairs that came equal or even with intensities the reverse of that noted above. When we reached the click-shock series,the influence of attention was very marked. The

indifferent series indicates an almost complete subjection to the shock; but when attention was given the hand, the shock-stimulus was usually weakened, and at times to so great an extent as to leave room for doubt whether it had really been sensed or only expected. The only series from which can be taken individual cases specifically noted, is the click-shock one, as follows:

17. TIMES WHEN ORDER WENT

SUBJECT.	WITH ATTENTION AND		AGAINST THE ATTENTION AND	
	With Faint.	With Strong.	With Faint.	With Strong.
D.	32	5	17	91

In this click-shock series the case for S. when the shock leads, is like that in the shock series (Table 5),and when the click leads, like that in the click series (Table 1). That is, in the former the number of correct answers and the direction of attention go together; in the latter they separate. The same is true for Miss Hamlin (in unpublished tables), but not for D., who varied his attitude often, but held to the original bias of faint intensity and priority. Because of this bias to "faint, therefore first" (p 545), a likeness marked as most appropriate suggested itself to Cinderella,—quiet before her assertive rivals, yet recognized finally, by her quality, as the true leader. Probably the comparison is only an elaboration of the struggle present from the outset, between a "feeling" and a "time" order, *i. e.*, faint and strong intensity.

The occurrence of the ghost-like after-image of the shock which persisted in the hand until it was given notice, though the original shock had been ignored, marks for introspection a difference between the so-called inner and outer forms of attention, — because the after-image (and oversight of its original) was most common when attention was most strongly concentrated on the hand. So far as inner attention is concerned, the appended table shows that with D. the judgment goes with the direction of attention. When stimulus and attention are on the right side (left hand), or *vice versa*, by making many wrong answers for the opposite side, the subject raises the number of correct answers *with* attention, to a good figure. But the particular difficulty found in this series lay in the location of the shocks, a feature that comes out more markedly in the trials with indifferent attention. In order to get 137 answers to a R. first series, there were given 285 trials; to get 144 answers to a L. first series, were given 247 trials. The shocks would not remain in the hands, but they gravitated to or toward the median plane. At times their fusion was complete on the Cyclopean eye order; very often it was partial, as when the right-side shock remained in place whilst the left-side shock approached it more or less.

18. "CROSSED HANDS" SERIES.

SUBJECT.	INDIFFERENT ATTENTION.						DIRECTED ATTENTION.									
	R. First.			L. First.			Right First.					Left First.				
	a	Ans.	b	a	Ans.	b	a	I	b	II	b	a	I	b	II	b
D.	285	137	89	247	144	67	50	26	20	24	5	47	23	1	24	19

a, Number of trials; *Ans.*, number of answers; *b*, correct answers; I, attention to right; II, attention to left.

Of the cases of total disappearance of stimulus there were on the right side (*i. e.*, from left hand), forty-two; from the left side (right hand), sixty-six. Twenty-one of these disappearances came in groups of three or more; the remainder were scattered or in couplets. The total loss of one stimulus is probably the extreme of translocation. The illusion is probably due to the fact the median plane is the most favorable region for sensory focus; here, or in right-handed people when confused a little to the right of it, would be projected ordinary stimuli sensed under unusual conditions.

In general it may be said of this section of our experiments that voluntary attention aids one to break up the course of his normal errors, or constant bias (cf. Tables 4 and 13). Aid is got by attending to the weaker stimulus of a pair given to disparate senses (cf. Table 7), because so to do is to inhibit in some degree the response to the stronger. It does not follow that results will be bettered by this attention; that can be seen only when the entailed disturbance ceases and action becomes again uniformly adjusted. For example, in the single-sense series "inner and outer" attention were normally balanced and the judgments were fairly correct. But in the disparate-senses series it was necessary—to attain an aim—to shake off the dominance of the shock; any means to do so would have the result got—of equalizing the number of answers for the two senses. In this way is it that attention is so effective in producing illusions, inverting time-order and the like, because the process set up by its interference is unlike the ordinary procedure it disturbs. Manifestly, attention may confuse as well as make clear. The disturbing effect of attention's strain to be inferred from the tables given, is confirmed by two side series carried on with Mr. G. W. A. Luckey, using medium and faint (*i. e.*, just perceptible) clicks, R. and L. leading in irregular alternation. The subject aimed to hold himself "alertly indifferent" throughout the series.

19.

MEDIUM.		FAINT	
Number Given.	Per Cent. Correct.	Number Given.	Per Cent. Correct.
500	83	460	76

To get the faint clicks it was necessary for him to tense to a high degree, and this effort brought on a fatigue of "indifference" which was fully as exhausting as one from great "concentration." As the muscles of response tired (from whatever cause), the consciousness dulled. In connection herewith may be inserted a statement of the whole number of correct answers given by S. and D. in all the series under discussion.

20.

Subject.	Indifferent Attention.	Directed Attention.
	Per Cent. Correct.	Per Cent. Correct.
S.	70	70
D.	76	69

If we extend our survey to the three sections under which our experiments were conducted, it is safe to make the following statements:

1. Attention is an aid in those reaction-time experiments in which the aim is to reproduce a given series—be it muscular or associational,—because in these the general conditions, as well as the especial incidents which a subject soon comes to make use of, serve to give cues. Thus one is enabled to "perceive the probable," and the expedited reproduction of the anticipated response at times leads to the *vorzeitige* reaction.

2. Attention may or may not aid in association, or rather, in the recall of associations, when we take note only of quantity. When regard is given for the presence of familiar associations, such as would be expected to appear first in ordinary stages of attention, the attention strain proves a hindrance.

3. Active attention is a positive detriment in new work whose cases must be decided each for itself. The kernel of active attention is prevision, and always prevision of an act. If the strain be great enough, instead of facilitating perception, it weakens the intensity of the first stimulus and thereby makes it other than what we await.

We may go further and characterize as disadvantageous attention when applied to the details of any work, in so far as regard is had for quick and correct execution; for acts that can be done quickly are habitual,—any interference with them, by means of attention, is in its very nature the putting of undue stress (or tension) on one link. In brief, attention is an aid to speed and surety only when and in so far as the conditions are the reproduction of a known series, *i. e.*, the reinstatement of the probable; and it is thus helpful only when the conditions converge on the few possibilities that are to be given. Active attention aids in attaining new conceptions by interfering with a habit series, thus making possible a change in direction of discharge. Passive attention aids by suspending actions that if under way are possible diversions, thus giving the stimulus a clear road to follow in the most habitual mode. The two are phases of every act, and are meaningless apart; nor can one be sure, in strange conditions, if his attention effort will be profitable or the reverse.

II.

Before continuing further the discussion of observations made whilst carrying out these experiments, it will be well to review briefly the problems of attention as these are now formulated. For the present purpose it is advisable to restrict our historical survey to the empirical psychologists, and of these to begin with Condillac, because of his elaborate theory.

Fancy a statue, says Condillac, built within on the plan of a human body, but with all inlets (senses) closed, and under the control of a master who opens them at pleasure. The statue is in every respect like a man, save it is absolutely devoid of ideas. By manipulation of the sensations ideas are built up, for judgment, reflection, desires, passions, etc., are only sensations which transform themselves differently (1-pp. 39, 40). The first sense opened is smell. The statue, modified by contact with an odor, knows a new state, though what this is, in our terms is unknown. With this sensation and the knowledge of it, appears also attention; to sense, know and attend to are one and the same. Henceforward experiences are attended by pleasure and pain (1-pp. 44, 45). In an analysis of the faculties of the mind, Condillac distinguishes between a general view of a landscape and a discernment of a particular object in the scene. This look, by which the eye tends to the object on which it is directed, is an action; for this reason it is called attention; this direction of the organ is the only part the body has in attention. On the part of the mind, attention is one sensation, experienced as though it were the only one, *i. e.*, it is an exclusive sensation. Comparison is a double attention (2-pp. 363, 364). To return to the statue : The odor which the statue senses does not vanish so soon as its source ceases to act on the nose. The attention given it retains it, *i. e.*, there remains an impress more or less strong, in accord with the degree of attention. Behold the memory! (1-pp. 48, 49) Possessed with a memory, the statue is a person, though all his psychic life is expressed in terms of smell (1-p. 89); this individuality is shown in the use of the personal pronoun. Why does the statue say I ? Because we think only in words. Language is expression, and the elements of the language of action are innate (2-pp. 401, 402). Since the mind can never get away from sensation (1-p. 3), the work of reason is to clear up what was implicit in former experience. For, while the first sensation-contact does not produce a full idea, subsequent ones do so, and these, he assumes, know as we know them (1-p. 89). Evidently Condillac confuses contact, sensation and perception, and by piling up many of the first, believes himself able to produce the last. Looking as he did for all plus to come from without, he puts attention at the gate, and sees its presence in the action, as shown in the adaptation of the sense-organ that conditions the reception of an impression. This readiness is an integral part of the sensation, and the more exclusive the sensation, of necessity, by definition, the greater the attention.

It is easy to cross-question Condillac into confusion. If the statue knows its new state, why should it not know its former condition, prior to all sensation? Evidently the "I" that marks the advent of personality is not a smell term. His explanation of the origin of memory is rank tautology. Yet he helped set the trend of interest in mind-study toward the expression side, and experimentation, while it has made ground for the science of psychology, has also helped to make clear the unsoundness of some of the earlier assumptions.

Speaking broadly, we may say those who yet hold views on attention like Condillac's, know little of experiments; for them there is no need to demonstrate psychic power.[1] This point should be kept in mind, for too commonly it is assumed that experimental psychologists are not psychologists at all, but physicists who are anxious to reduce all life to terms of motion. But the distinction felt by Condillac, between consciousness and its content, though blurred in his words, is quite as real as is the intimate body-mind connection he noted, and these two phases are inseparable in any full study. At first the experiments in psychology were scattering. Bessell's solution in 1822 of the personal equation, Helmholtz's measurement of rate of transmission of an impulse through a nerve, 1850, Fechner's "Psycho-Physik," 1860, and, finally, Donder's work in 1861, are matters that serve to show how the problem of attention, as a subject for experiment, gradually came to the fore. Fechner was a pretty thorough-going advocate of the Attention-is-in-the muscles theory, and from the appearance of the Psycho-Physik there was much work done in German psychology which involved the use of attention. "Since the suggestive dissertation of Herbart in 1822 *(De Attentionis mensura causisque primaris)*, attention has come to play a very important rôle with psychologists, with whom it has had much to do in undermining the theory of faculties, until, as is known, with Wundt it may be called the central psychic category."[2] In 1873 Exner published his *Experimentelle Untersuchung der Einfachsten Psychischen Processe*, in which great stress is laid on attention. Besides the studies of Helmholtz, there appeared within the space of a few years the advance guard of the host of modern psychologies: Delbœuf, 1872; Hering, 1861-75; Brentano, 1874; and in 1874 Wundt's first edition.

Wundt's aim was to make psychology explicative, and for this purpose he made use of measurement. He starts from the psychic side, and his interest is chiefly in the unification of experience, his "Apperception." "One might say the last great step in Psychology was taken when Wundt pointed out the incompleteness of the English Association theory," says Lange (p. 395). To Wundt the natural expansion of the unitary nature of mind constitutes reason, and by definition of its nature, precludes the possibility of thinking more than one thought at a time. His psychology rests on this, that there is a physiological, or unconscious, basis for sensation; once given sensations, *i. e.*, psychic facts, and reasoning is inevitable. The impression I get is that Wundt makes little of the "unconscious" as a field of study. He calls the muscular form of reaction a pure reflex, destitute of any psychic worth (1, II p. 310), and though he hopes we may learn more of the "physical dispositions" left by sensations, he doubts if their study can throw light on the origin of the "psychic dispositions" (4th ed. II, 265). In the first edition (4th Abschnitt, 18th Capitel) he holds that the elements which are yet without (on the nascent side of) consciousness do not have a unity. Despite the fact that ideas seem to pop into consciousness fully formed, their unity is given them by consciousness only. Wundt is not one who believes in a stream of thought; the break between the apperception of A and that of B, he says, is due to the fact the mind must turn from A to B; and again, our perception of time is due to the nature of apperception,—the mind must go in jumps (4th ed. II, 429f.). In the first edition (p. 717) we read: "Because in the synthesis of feelings *(Empfindungen)* and in

[1] *Vide* Spencer's "Inadequacy of Natural Selection," *Pop. Sci. Mo.*, XLII, p. 801, n.
[2] G. Stanley Hall, *Mind*, 1883, p. 177.

the association of ideas *(Vorstellungen)* consciousness comprehends itself as active, that outering of it arises which we call attention. Manifestly in any moment consciousness has not made equally prominent all the inter-relations of ideas, but has turned almost exclusively to a few. This feature may with advantage be compared with the action of the eye, and the focusing of consciousness be called inner sight." At this time, it seems, Wundt's ideas were simple; attention was the expression (in muscles) of the working of consciousness. But the fourth edition reveals how little importance he attaches to expression, and how fully he is under the spell of his *Blickpunkt* figure. Just how many and what parts of the process whereby sensations are received and elaborated are physiological—according to his theory,—Wundt does not make clear; but to him, now, attention is a feeling which accompanies psychic activity, and feelings thus far are treated by psychologists in a cursory fashion—in lump. This activity which underlies is apperception, a strictly psychological fact, and to it Wundt devotes his study; the physiological accompaniments, so called, get little of his notice. Sufficient for him is it that apperception and not the intensity and *quality* of a stimulus determines the line of sight (I, II, 121). Consciousness is a *Blickfeld*. Wundt assumed his inner force, and busied himself with experiments to determine how rapidly it could act under certain factitious conditions. His consciousness is closely held to his inner *fovea*, and to use his own expression, what exists outside the circle of clearest vision, is ignored; of ideas outside clear consciousness we can say nothing, save historically.

Coincident with Wundt's first edition is G. E. Müller's *Zur Theorie der sinnlichen Aufmerksamkeit*, a study which emphasizes the difference between outer and inner attention, and finds the former to be dependent on the latter. Dualistic interaction must, on rational grounds, be possible (p. 3). Not the objective intensity of the stimulus-effect, but the perception, is increased by attention (p. 4). Sense-attention is the reinstatement of certain conditions of the sense-organs (p. 50). If nerve-cells can act on mind, then mind can act on nerve-cells; since mind can act on motor nerves, it is reasonable to suppose it can act on sensory nerves (p. 3). Images or vibrations travel down sensory nerves and modify incoming sensations (pp. 86, 87). A mental state in possession of the field can bar out rivals. In voluntary sense-attention the mind consciously gives the desired adjustment to the sense-organs; but objects have the power to suggest the same adjustment which is made involuntarily by the mind (p. 110). These extracts serve to give fairly well the general standpoint of the Leipzig school. Sense-attention is a minor matter to psychologists, and is dependent on inner initiative.

In 1888 Nicolai Lange published his *Beiträge zur Theorie der sinnlichen Aufmerksamkeit und der activen Apperception*, in which he more definitely stated the subordinate value of sense-attention. Were it not for the mental power to attend to faint impressions and to ideas, our minds would be open to all the blasts of experience; in which case even the sense-impressions themselves would have no meaning, because of no interpreter at the center (p. 391). Active attention consists in intensifying one idea-complex by the aid of another; it acts after ideas are in the mind. For long no other explanation was given why attention flickers than: it is the nature of apperception so to do. It was said the fixated idea was held by an act of will; or, that opposing ideas were inhibited. Lange passed by these reasons, and endeavored by experiment to show the variations were due to the coming and going in the mind of images of the fixated stimulus. Sense-attention, then, consists

in the assimilation of a sensation by its corresponding memory image which has been actively recalled. These images can be recovered actively only by means of voluntary innervation or movement impulses which are associated with them. This process we call active apperception. The variations in active apperception are conditioned by the general relativity of psychic phenomena, and form the cause of all other periodicities in consciousness, such as are expressed by sense-attention in the time-sense and in the periodic phenomena of memory (pp. 421-422). This theory of sense-attention (which Wundt adopts), demanding an inner image, to which the sensation is assimilated, is the old problem of perception, and reminds one of Parmenides' "Like is known by like." Probably in Wundt's mind the resemblance is only superficial; but I find it hard to get Wundt's position clearly.

Ludwig Lange, in the same volume of the *Studien* (IV, pp. 479-510) published a report of his *Neue Experimente über den Vorgang der einfachen Reaction auf Sinneseindrücke*, wherein he noted two very distinct methods of reaction — the muscular and the sensorial. These are too well known (in words) to require description. Wundt adopted the conclusions of the Langes. The work of the one gave him a criterion whereby to reject all experimental study in psychology which does not proceed on the Wundtian lines; that of the other furnishes reinforcement to his apperception-centre theory. The Langes, in harmony with their teacher's position, consistently refuse to extend their study as *experimental psychologists* into the field of "the unconscious," or the physiological.

It is not my wish to exploit the controversies that have arisen over Wundt's theses,—some of which are bitter. The opposing camps are separated more by innate tendencies or philosophical bias than by differences of fact. Some men by nature cling fast to the tangible. It is easy to say they take short-sighted views, and give but partial accounts of the problems they investigate; they grant the truth of the charge, and try to remove it by discovering more. Their results are but fragments; we need not look to them for complete theories. Two of these it will suffice to mention.

In 1889 appeared Ribot's *Psychologie de l'Attention*, comparable in its general method of treatment, critical, with Müller's *Zur Theorie der sinnlichen Aufmerksamkeit*. Müller's great interest centred on the psychic initiative, Ribot's on the mechanism of attention. Ribot recognizes the subjective aspect of psychic phenomena and asks, what are its bodily conditions? These he finds in the more or less isolated (differentiated) muscular tensions, which in turn call into action limited portions of the nervous system. The ordinary round of life exercises the brain normally, that is to say, all parts function in an habitual way; new conditions disturb this equilibrium and the new tensions arouse new cerebral arrangements, and thus produce the states *known* as spontaneous (natural) or voluntary (artificial) attention.

But it is to Münsterberg we must turn for experimental investigation of the motor basis of attention. Much has been made of the antagonism between the views of Münsterberg and those of Wundt, yet, as has been said, the difference rests more on innate bias and method than on fact. To one attention is a feeling, to the other it includes the activity behind the feeling. After Wundt adopted the conclusions of the two Langes, the whole Leipzig school felt obligated to close one portion of the field to experiment; whereas Münsterberg, believing there is a province of psychological *phenomena*, set himself to trace these phenomena. Münsterberg maintains the distinctively psychological feature of this study, but sees

no reason to halt so long as there are "physiological" facts with psychological meaning. The results of the Langes gave points of attack, and in the following year (1889) appeared Münsterberg's *Beiträge*, I and II. In the first are set two problems. (1) May not the psychic results reached by voluntarily exerted *Vorstellungsbewegungen* be got without the conscious use of will? (2) Is it possible, by studying judgments whose premises are variable, to find the spot in the psychic mechanism that concerns the transition from passive to active *Vorstellungsbewegungen*? (1-pp. 67-68.) "To him who endeavors to so set forth the psychophysical theory that all the phenomena of consciousness can be referred to changes in the physically conditioned contents of consciousness, no greater bar to progress exists than the distinction between the field of non-voluntary association and that of voluntary *Vorstellungsbewegungen*" (p. 64). The sensory form of reaction requires more time, say Lange and Wundt, because it includes the times needed for perception, apperception, volition and innervation; the muscular form is a mere physiological reflex. The former is open to great variation in time, but has a sure outcome; the latter is uniform in time, but liable to error. Can I get results qualitatively sensory, and which (per theory) are attainable only by the sensory form of reaction, by using the muscular form? asked Münsterberg. He did. The judgments given (as results in his experiments) are such as ordinarily require reflection and choice; the times correspond to the motor requirements.[1] Manifestly, "of any sequence of the various acts we cannot speak; yet with this sequence stands or falls the apperception theory" (p. 121). Ordinary consciousness distinguishes voluntary and involuntary mental acts, and is supported by the prevalent psychological school, as represented by Wundt, which sharply separates apperception and association, denies the former is derived from the latter, and affirms that choice and judgment are not influenced by the contents of consciousness, but are basal. The apperception theory is safe so long as it remains within the psychic sphere. But when we think of the brain and the result of physical changes there on the content of consciousness, we see the two are not separate; physical dependence must be related to physical causation (cf. pp. 107-108). Even though the short form be as Wundt says, a mere reflex, yet "I believe it is competent to form a point of departure for the investigation of complicated psychic acts" (p. 110). In cases of pure apperception the time should be shortest, according to Wundt, when attention is on the first member of the series, the signal; Münsterberg found it to be shortest, in the sensory form, when attention was on the last member, the movement (p. 114, 115). If, one may ask, both reaction forms have psychic worth, how account for their differences? Münsterberg's reply is, most of the work is done, in the motor form, before the measured part of the experiment begins (p. 171). When the conditions are known and the order is to react quickly,

[1]The work, in brief, is as follows: With a five-fingered keyboard and five classes or possibilities of answers, the subject makes in the shortest time a finger movement to express a reply to a problem given by the operator. *E. g.*: In the seventh series of experiments, with fingers assigned to groups: Poets, Musicians, Naturalists, Philosophers, Statesmen, a name—*e. g.*, Locke—was to be listed under the heading Philosophers. In this series the average time taken when the sensory reaction was used, was 1122σ; with the muscular form, but 437σ. The second part of the work was given to a comparison of free association with acts of simple judgment. Beginning with random association the experiment was conditioned, both subjectively and objectively, until complicated judgments were called for, yet the reaction-times did not increase in like ratio so long as the short form was used.

the will to act already exists in the idea when perceived. Thus it is the reaction is made before the signal has roused what we call "its meaning" in the mind, before it is apperceived, and before any relation between it and the reaction has found a verbal judgment (p. 166).

Part II of the *Beiträge* contains an article, *Schwankungen der Aufmerksamkeit*, wherein is detailed a re-examination of the work on which N. Lange based his theory of inner initiative for sense attention. Wundt's first care is to preserve the unity of consciousness, Münsterberg's is to preserve psychophysics. If we say consciousness can turn away from one part of its content to another, like the physical eye, then psychophysics is at an end (pp. 70-71 and 123). The outcome of this study is that the contents of consciousness and not consciousness itself, change with the variations of attention, and that these variations are due to peripheral causes (*e. g.*, muscle fatigue) and not to presence or absence of an inner assimilating memory image. "I believe my experiments point to that conclusion which Lange rejected, namely: these variations are conditioned peripherally and not centrally. Understand me; I do not say that attention in general is only a peripheral phenomenon, nor that all variations in the content of our consciousness find their psychophysical cause outside the central organs; I do not say that alterations of our special cases run on unconnected with central reflex paths, but I believe that this particular effect, the coming and going of the perception, is due to changes within the sphere of the contributing sense organs" (p. 94). In *Die Association successiven Vorstellungen* Münsterberg (3) describes a study of the question: Is the reproduction of ideas determined by an inner relationship alone, or must there be an outer link, arising from the simultaneity or sequence of the stimuli? He decides for the latter, and holds that idea *a* dissolves itself in the innervation that makes the tension which calls up *b*. It lies in the nature of the muscular system to associate its movements serially on reflex lines; hence one movement is the stimulus for its successor. The various stages of this series are reflected—in consciousness—as associated ideas. Münsterberg employed the memory-span test, using letters seen singly. His first group was made with free attention; the second group was with attention distracted by mental arithmetical problems performed aloud. In the latter group his ability to reproduce the series was much diminished because the vocal apparatus was so employed as to prevent utterance of the names of the letters seen.

The fight is still on. Each side believes in a psychic force—the motive power; each believes objects can arouse this force. The one takes the mind after it knows what it does and says that all which goes before is inscrutable to psychology (but cf. Wundt, 1-II, p. 279); the other trenches on this preserve, and sees in the connection of feeling and muscle tensions a preliminary stage in the formation of ideas which is fairly safe matter for the psychologist's study. It may be said the efforts of the one are on Kantian lines to push "understanding" back into the territory of sense (cf. Wundt's innervation theory, and passive apperception); of the other, to advance "mere association," brain processes and muscle tensions, into the field of mind. In Vol. VIII, *Philosophische Studien*, are articles by Eckener and Pace, based on re-examinations of the contradictory experiments of N. Lange and Münsterberg, which claim to substantiate Lange's conclusions. The matter reminds us of the claims made for the innervation theory. The latter was plausible, but when, after long dodging it did give tangible

"proof," this became aid to its opponents. The conclusions of those who defend the inner initiative must always rest on inference; their proofs when brought into the field of action become Pyrrhic elephants.

III.

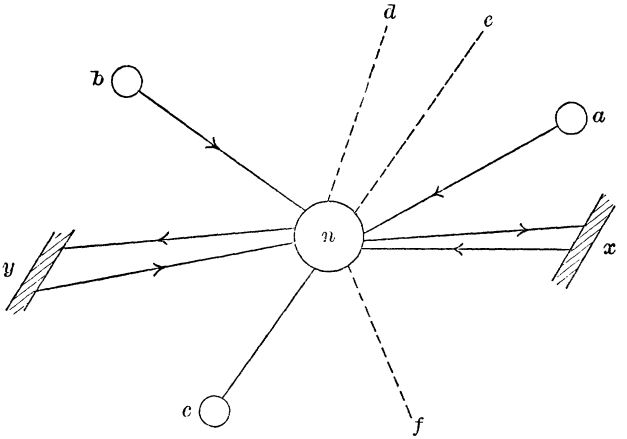
After one has been working in a given field for some, time there grows up in his mind an almost unconscious attitude toward the subject of his study,—the result of his reading and experience. It is hard to describe this position simply, because in its darker parts there lie all the explanation and harmonization one needs; these are felt to be there, even if not evident to a critic. Yet some clue to a writer's bias is helpful; hence the following statement of the thesis maintained in this paper, given with the hope the argument will be examined to learn the meaning put into the words used.

A popular psychological assumption is that mind is awakened by stimuli from without,—the production of sensations. This view may be put thus: *S* O——o *s*, in which *S* represents the central system, *s* a sense organ. A stimulus in *s* passes to *S*, and there is known. From *S* in turn the stimulus-force, or idea-force as it should now be called, passes out to other parts of the organism. Whether it passes on motor nerves only, is in dispute. G. E. Müller, resting on Helmholtz's experiments, claims an idea can and does retrace the sensory path and awaken in the end-organ sensation. Wundt, James, and most psychologists hold that consciousness is an inner force that expends itself at will—on motor lines; Bain makes much of inner spontaneity plus fortuitous combinations of desires and movements, which enable the mind to satisfy its wants. Wundt, James, Müller and others hold to inner association and arrangement of ideas. Opposed to them are Bain, Münsterberg, Ribot, Féré, who hold to muscular successions that condition association. The former teach that consciousness precedes and directs attention; the latter claim it follows the muscle tensions that are "attention." The position most in accord with the common understanding of our subject is that held by the men of the inner initiative. *E. g.*, for Prof. James "selective attention" gives us what we call sensations, *i. e.*, picks out certain vibrations and arranges them in the order in which they come to consciousness; Wundt's apperception theory is akin. This mobile inner force can so deploy its energy as to facilitate sensation by preparing the end-organs for the reception of stimuli, and even, as some claim, by anticipating in the sensory nerves the stimulation; it also helps us to perceive, conceive, discriminate and remember; it gives us time-order and ideas of number; it quickens reactions; it both magnifies and suppresses feelings and ideas; it interferes with our bodily functions. But experience shows us that attention is not always controlled from within, and to meet the need names are given, *e. g.*, reflex and conscious, involuntary and voluntary, and passive and active, whereby it is hoped the attention forms may be classified. Here again disagreement prevails; to the strenuous advocates of an inner force a self-directed activity can be neither reflex nor involuntary. Wundt, in the fourth edition (I, II p. 278), lapses somewhat, gives up the terms voluntary and involuntary, and claims that attention is characterized by passive and active features, and that the former always precedes the latter. This inner-activity view is one that as a whole lends itself to easy comprehension; only when its bases are touched does it disclose gaps. Against it are several theories. Spencer treats the mind from a totally different stand-

point, and so ignores attention; to Ward it is one of the fundamental divisions of mind. Yet another position, and one that in some respects meets with favor because of its tangible reference, is that attention considered on its psychic side is only a state corresponding to a physiological state of activity in the muscles. The advocates of this view—to speak in a general way—are Bain, Münsterberg, Ribot, Féré. No two of these men agree throughout, yet for general purposes the classification may stand.

The remainder of this section will be given to an attempt to formulate a working hypothesis of a view that sees in attention *per se* a muscular basis. The effort will be to apply in another way what has been in the air so long as to be general property; *e. g.*, Hall's insistence on motion as the basal psychic fact, James' emotion theory, Münsterberg's muscle-link for association, and the many minor studies akin to Lehmann's.

The annexed figure may illustrate the process wherein ideas are made manifest.



a b c are sense organs; *n* is the central nervous system; *x* a muscle group whose tension proves favorable to use of *a*; *y*, muscle group that becomes connected with *b*; *d e f*, other muscle groups, some or all of which may, and at times do, tense simultaneously with *x* or *y*, or both.

Assume the discharge into *x* is definite. Then my thesis is: When the stimulus comes via *a*, it must end in *x* before consciousness can be said to exist. The process *a-n-x* is an indecomposable unit which corresponds to the single state of consciousness that knows (or is known as) the given sensation. *a n x* gives the sensation-tone, the qualitative characteristic of the particular experience; but, alone, it is in no general sense of the word to be considered as "known." *a n x* is the condition of a bare sensation (in so far as such an abstraction can be considered); the conditions of knowing *a-n-x* are the related tensions in *y-d-f*. But the discharge from *n* is seldom if ever exclusively into *x*, though it is assumed the greater part is so sent; instead it irradiates and sets up a general readjustment, into which comes a new disturbing factor in the incoming sensation from the tension of *x*. This latter state, *i. e.*, the reception and assimilation of *x*'s tension-sensation, gives us knowledge about the former *a-n-x*

state. *a-n-x* gives a simple idea; if it can be said to be known at all, it is absolutely relationless; no attention can be given it until its final term has been referred back to *n* and redistributed. Thus comes the claim that attention, as a psychic fact, follows and depends on the muscle tension, and we do not attend to an idea until after the idea-stimulus has run its course. The links that connect our ideas and bring them into the field of consciousness are these kinæsthetic sensations, and our personal power is shown in rejecting some and holding to others. As our bodies could go nowhere save for bone resistance, so our mind's endeavors would be fruitless without muscle objectification. It may be the stimulus that reaches *n* is of a kind or degree that has no preferred outlet; in this case the many and inharmonious tensions produce a state of emotion, *e. g.*, fear, with beating heart, panting breath, protruding eyes. Normally, however, one path does get preëminence, and the sensation gets a relatively definite name or expression—in vocal cords, facial muscles, a shudder, or otherwise. Theoretically it was at first a matter of indifference whether *a-n* ended in *x* or in *y*; practically, with bodies constructed as are ours, some lines of discharge are innate. Yet connections may be and are made between, *e. g.*, *b* and *x*, *a* and *y*. Thus names call up not their own "ideas," but their "meanings."

The correlation of tensions is one aspect of a process of which the other is the unification of ideas. This is shown in the acquirement of an art, *e. g.*, writing, cycling. At first are many unneeded and untimely efforts and much confusion as to one's course; with practice the irrelevant acts are suppressed and their force turned into desired channels. In this correlating process, so long as there is a prospect (or feeling) of success, the subject is interested; when failure is inevitable, interest goes. Herein is a clue to the nature or origin of interest; interest is the inner aspect of the muscle-correlation process. Interest attests a nascent adjustment of actions, and roots in the unconscious because at bottom the muscular harmonization is physiological. Interest, however, is never present in first sensations, because it partakes of and follows the intellectual element. First experiences awaken in us emotions, *i. e.*, states corresponding to first or incomplete tensions and tension-adjustments. Emotion lacks clearness because it has no definite or dominant tension to tie it to the objective, and an emotion is difficult to reproduce because it lacks a special muscle element. Given the motor means of recall, and interest appears as an index of the smoothness (or possibility) of interaction of various ideas and their tension-elements. To this extent interest and attention are running-mates.

To the claim that attention can be present only after the idea that evokes it, the objection may be made that a babe is all attention to every intense sensation. But the babe's ideas get their set by these very tensions, and grow in clearness as the tensions pass from mass to particular; unbroken attention is equivalent to catalepsy. The state exemplified in the babe is what I understand Wundt now to assert in his statement, "passive precedes active attention." Further, the stimulus passes to its reaction, the latter sets up an idea in mind; then—with one idea uppermost—comes will (James) or voluntary attention, *i. e.*, knowledge of what has been done, and prevision of a repetition under like circumstances. Yet this idea that is in mind is but a representative of the act to which interest attaches and for the sake of which we wish to attend. By conforming to it, we put ourselves in condition to get a repetition of the former stimulus and its results. How conform? By tensing one

and another muscle until we are aware of the correct mental state. The assertion: The presence of an idea before an act constitutes ac- active (or voluntary) attention, seems negatived when we consider the running-off of a habit-chain in which each step is preceded by its non-willed cue. In fact no sharp line can be drawn between passive and active,—it is a matter of the degree of tensions involved (cf. Münsterberg, 1, I, p. 67); to the actor the distinction is known by a wider grasp of related acts, which calls into play the higher centres, not necessarily to control, yet in action to accompany the habit-centres. We can attend to but one thing at a time, because to us, in our stage of growth, anything short of a unification of tensions produces a greater or less degree of emotion, wherein the harmonization of tensions and mental state are alike deficient, and one knows not what to think. As a matter of fact we can attend to two or more matters that do not interfere in the modes of expression, though here as in any other concatenated act, now one, now another part of what is really one compound act is clear in mind. Yet this differs in no essential respect from any art.

When any part of the body is the object of attention we know we attend to it by experiencing the tension of its muscles, our attention is assured by the strain. When a sense is used as a medium of attention to a stimulus, the strain becomes of minor consideration—necessary to certify the mind is rightly directed, yet of value only as a basis of comparison with the change induced by the awaited stimulus. The difference between active and passive attention, as these terms are commonly used, is that in the former the body-mind complex is in a condition favorable to the recognition of likeness or difference of in-coming stimuli; in the latter comparison is difficult, for either of two reasons: (a) general state of relaxation, (b) great tension of a part not directly concerned in the reception of the unexpected stimulus,—for in either case diffusion is hampered and meaning tarries. Yet comparison may not be difficult in passive attention if so be the stimuli are intense or much unlike, for under these circumstances either the force is sufficient to overbear resistance, or the unlike stimuli find outlet in free channels. The mind feels its freedom when it passes gradually from one object of regard to another, and does not when it goes by leaps, as though a creature of caprice; so we call the gradual progress "active," and feel an inner power, fore-seeing, hence called "voluntary."

Extreme concentration of attention, considered as an inner activity, defeats its aim in that the tension-process becomes greater than that which normally accompanies the awaited stimulus, and thus a disturbance is set up whose outcome is to fill the mind with an irrelevant strain to the exclusion of the one that belongs with the stimulus. Attention (and here tension is meant) needs mostly to be in other parts than those that mediate the stimulus, for thus all interfering action is checked and the parts concerned are free to adjust when aroused. Nor does this apply only to sensory excitations; the most abstract thinking is deranged when the body is out of its normal order. The condition most favorable to the highest state of general attention is the one called "alert indifference." The subject knows his stimulus will be of a certain kind and within given limits. Thus prepared the alert indifference was found to be at its best just as one's inspiration was near its maximum. At this juncture there is a momentary relaxation, which seems to be general. Efforts to attend soon exhausted the subjects. On the view that the muscle tension is an integral part of one's idea, and that maintenance of an idea in mind and maintenance of tension in certain muscles are two aspects of the same fact, it is easy to explain

this tire of attention. The eye fails to "see" clearly because the wonted channels of expression corresponding to certain stimuli are fatigued, although at the same time the eye itself may be in good condition. Like the would-be jumper who takes a long run to get impetus and is exhausted when he gets to the scratch, so one who overstrains his muscles in expectation finds himself unable to seize, or else to react on, the stimulus when it comes. It may be well to repeat there are two distinct facts to be kept in mind of every act of consciousness: the one is a relatively simple chain of three links—end-organ, centre, muscle, and this constitutes a sensation; the other is a complex of many such links, and forms an idea.

Much has been said by the supporters of the central-origin-of-attention theory of the phenomena of attention got by introspection, but an examination of these statements will, I think, show that the condition immediately preceding any particular phenomenon is a muscle state. In other words, the psychic state is indissolubly bound with and dependent on a tension; attention follows, not precedes, that to which we attend.

Helmholtz, to illustrate the freedom of attention, cites the fact we can hold to a faint stimulus whilst a stronger one to the same sense is debarred (pp. 971-2). Evidently it is assumed that stimuli produce reactions proportionate to their objective intensity. That this conclusion is untrue, in so far as our measure of objective intensities goes, is well known. Were the neuro-muscular system always to return to a neutral state after each response, we could expect the stronger stimulus to draw the attention. Further, there seems to be the assumption that a stimulus to, *e. g.*, the eye, is shaped by that sense into an idea. James (I, 50) exposes this error. Hering (pp. 84-5) shows that clearness (the point involved in Helmholtz's claim) depends on the relation of the given sensation to its sensation environments; in other words, that the clearness of a sensation is measured by the relative strength of the interrelations of the particular tension response to the other tension states of the body at the moment. The "stronger stimulus" fails of entrance because opposed by the tension state favorable to its "weaker" rival. Wundt also accords: "The clearness of a *Vorstellung*, whether sensation or memory-image, is conditioned both by the strength of its perception elements and by the sharpness of their apperception" (1, II, 271). Interpreted in the light of the experiments given in this paper, Wundt's words state the equivalent to (a) proper functioning of the end-organ and its immediate responses, and (b) the adjustment of the latter in the general body-state. Wundt admits that an unexpectedly strong stimulus breaks up the preparatory attention-tensions (and this happens at times to such a degree that the new stimulus apperceives the mass that had awaited it); but, apparently, he does not recognize that the over-tension of the muscles concerned in the apperception of the in-coming stimulus also prevents or warps apperception. So far as clearness is concerned, its conditions may be summed up in: If attention checks irrelevant tensions, *i. e.*, if it is expended in such a way as to leave free the muscles needed to receive the awaited stimulus (or idea), it aids; if it checks these constituents, it hampers clearness.

Fixate carefully a small object (and the greater the attention the smaller is the field of application) and it soon disappears. It goes when the feeling of strain is greatest, says Helmholtz (p. 365) and Müller (p. 92). The cause of the disappearance is not that "the strain-idea has driven the object-idea out of mind" (cf. p. 569 for account of rivalry between strain and stimulus), but that the

tensions have diffused into the muscles that serve to give meaning to the acting stimulus. Wundt again: "Impressions qualitatively different require unlike adaptations for their reception. Further, we note that the amount of the feeling of inner expectation keeps pace with the strength of the impression whose apperception we complete. On the exactness of this adaptation depends the sharpness of the apperception. The latter is sharp when the inner attention exactly corresponds to the strength of the impression" (1, II, p. 271). This strength, as we have seen (pp. 548 and 550), is conditioned very largely by the tensions that receive the shock; and we are not obliged to assume any strained condition of a hypothetical inner entity as does Wundt. Our inner expectation really keeps pace with the degree of tensions, and when these lack order their conflict throws the mind into a state of emotion—the inner aspect of the confused muscles. In the experiments herein noted, perception of the time order of (faint) clicks, in § C, was best when there was no feeling of strain whatever; the strain Wundt speaks of is probably only the holding in check of muscles which might inject a disturbing factor into the intended response (cf. with experience of Mr. Luckey, p. 550). If we consider the process of apperception as progressive coördination, we see why consciousness lapses as habit grows,—because attentive consciousness is dependent on shifting tensions; as muscle groups coördinate and function *en bloc*, they escape mutual conflict, and hence give no occasion for opposing states of mind. That reactions do tend to an average status, wherein discrimination or attention lapses, is certain; it is shown by our "constant bias," by Leuba (p. 382-3), who considers it a feature of sense-memory, and again by Daniels (p. 561, n.), who notes the recurrence of certain stock errors. We are debtors to our mistakes if we take them up into consciousness and definitely build them into the way to the correct end, for thus they "lapse," as do all the stages of a series, and so no more offer seductive diversions, but form part of the wall within which our thought runs. Until such assimilation of mistakes is made, the latter are a constant source of error, and may come to be the habitual normal course of reaction. In view of these facts, it seems evident it is these possibles of reaction that determine apperception, and that Wundt's assertion, "Not the intensity and quality of a sensation in itself, but its ability to excite apperception, is the determining factor for the direction of the line of sight," is, as Wundt means it, unfounded. Perception of impressions on peripheral portions of the retina, to use specifically the illustration that for Wundt is general, is either mediated by tensions in part different from those that function with the foveal region, or there is a momentary lapse from the prescribed fixation point. Helmholtz's perception with sides of retina (pp. 934-6) is in point; despite his claim, "attention is quite independent of the position and accommodation of the eyes," there is no need even here to invoke the aid of a hypothetical inner activity. Vision with the sides of the retina enables one now and then, in flashes, to perceive the clear black and white of a disk when it is revolving at a rate sufficient to give a uniform gray. The very point so emphasized by Hering (Hermann's *Handbuch*, III, I, 548) relative to Helmholtz's experiment—that the line of sight must be held with perfect firmness—is the essential condition needed to let the side stimulus work. We cannot speak of eye, but must distinguish eyes and parts of each eye[1]; and to these parts respond different tension-complexes.

The ripening of apperception is a matter much dwelt on by

[1]Cf. C. L. Franklin, *Psychological Review*, II, p. 142, n.

Wundt (1, II, 399 etc.), who claims the mind can divide itself between two or more stimuli, or can perceive them simultaneously. *E. g.*, the stimuli got by the dial-pointer-bell apparatus need not be rivals, but, like two streams, may flow in gradually converging courses until they meet and mingle gently and indissolubly. Nor is the junction for Wundt a result of stimulation, but depends on the ripening of apperception. It matters not if there be no second member; if apperception is expecting such to come, it will act as though the to-be-interpolated stimulus had come, and thus produce "negative errors." Again, though the disparate stimuli have been given, if apperception is unripe, their taking up into consciousness is delayed until apperception is ready to admit them. The obscurity of the process, though great, is not lightened by the explanation of apperception, which "*ausdehnt sich auf die Gesammtanlage des Bewusstseins*" (1, II, 285). It seems fair to infer that by Wundt's view the two series of stimuli in question move in the sub-conscious, and fuse there. But if so, how can active apperception be said to control them? In my own experiments, results like Wundt's were often got, but explicable in a much simpler manner. In the reaction-time experiments, whilst reading, problems were side-tracked into sub- or semi-consciousness, whence their answers appeared in visual terms (cf. p. 565). As Wundt says, "The regular series ran its steady course as though no complication existed, and at a point the simultaneous stimulus joined itself to the former, not as a successive, but as an integral part of a complex idea" (1, II, 399). Yet this does not mean the mind divided itself between the parts, but that separate muscle groups responded to their stimuli, and when in a sufficiently tensed and non-conflicting state, formed the state common to all complicated acts,—and what acts are not in some degree complex? The same process that provides for the preservation of some parts in the complex is sufficient to ensure the forgetting of others.

Daniels' paper, describing work akin to Wundt's complicated reaction-time experiments, and to the study of Angell and Pierce, offers several points for comment. To the subject, while reading aloud, were read series of numbers of three figures each. The subject either ceased reading and at once repeated the number, or continued reading for periods ranging from five to twenty seconds before endeavoring to repeat. It was found the memory after-image does not last fifteen seconds in a reproduceable condition unless its response tension is repeated before its first set is spoiled by succeeding tensions. It is not that the after-image has been in mind,—in that it has a grip in tensions, lies the possibility of its recall. Table III, p. 562 (of Daniels' paper), a general summary, shows the part played in perception and retention by tensions. S., a trained experimenter with self well in hand, made uniform resistance to the impulse to diversion of attention from the reading; but as the stimulus summated its culminating part (the final number of each set) stuck far oftener than either of its predecessors. D., less trained, was unable to resist the onset of the number series, and shows an outgo to the initial number, a return to his reading (*i. e.*, former tension state), and another response to the final number. Here, as before, attention, considered as a conscious state, follows the tension response in every case.

IV.

In the opening paragraph is promised a summary of by-products of the experiments which suggested, and in turn get meaning from, the view of attention just given. The list that follows, considered

from any other standpoint, displays a motley host; but examined for tensions, as characteristics of direction of attention, it presents a homogeneity that warrants recognition. To designate the three sets of experiments, A will be used to indicate the reaction-time, B the association, and C the least interval, group.

In A and in the distraction half of B, the set tasks were more or less hampered by the many and conflicting demands made on the vocal cords. The mere fact that ideas are known in, or by, a nervous system necessitates the presence of some form of expression as an inevitable accompaniment of every stirring of consciousness. By the time any stimulus gets to consciousness, it has found outlet in muscles, and because of our great need for names, a part of this expression is usually in the larynx.[1] Hence use of the voice proved the most distracting device, because of the almost inveterate effort to put our thoughts into verbal form; unless other channels were ready, attention balked. Exceptions that go to illustrate how little depends on conscious direction of attention and how much on diffusion of the stimulus until it finds an accustomed channel, were found. *E. g.*, in A, problems given orally were side-tracked into semi-consciousness, whence they reappeared with visualized answers; in B, thought went on without special names, in a general yet accurate way. Yet in all these cases a general feeling of congruity is our guide, and we do not realize our errors—so frequent—until after they are made; in other words our attention, considered as a mental oversight, follows the tension. Daniels (p. 561, n.) notes an incident common in all similar experiments — the easy formation of habits of response; *e. g.*, any answer once given, whether correct or not, was often repeated. Here it is evident the mind is easily satisfied and directs its attention along the line of habitual tensions. In Daniels' case the vocal cords were in use, and the stimulus given (a group of three numbers) tended to evoke its proper response; as the subject felt himself yielding (*i. e.* as his cords tended to shift one position for another), he resisted not the thought, but the shifting of tensions by putting greater strain on those in use. As forgetting is not doing, so by refusing to name the numbers pronounced, the subject lost the power to recall them; later effort so to do led to discharge in the habit-tracts,—these being uninfluenced by the previous strain. For brevity I have spoken as though all centered in the larynx; while this may not be the case, the point involved is not affected. The fact that in C perception was not hampered by loud reading, save when the latter made one oblivious to sound stimuli, indicates the trouble caused by distraction lies not in the receptive, but in the expressive sphere. Two things cannot be done, nor thought of, at the same time if they need the same or opposing muscles for their execution; if, however, different muscle groups are exercised, many acts can be simultaneous. As so stated this is self-evident, yet many experiments have been made to prove it (cf. Paulhan); further may be noted: in A partial products fused of themselves; in B associations presented themselves (cf. Wundt, 1, II, 398-9); in C the click or shock gave its own order. In none of these cases, as a rule, were the results got by any "direction of attention;" they came in spite of distraction, were mediated by tensions other than those in use for the distraction. If the term "conscious" be restricted to those processes of which we are immediately aware, then the results just noted, of thoughts that appear full-grown, may be said to come from the unconscious. Ac-

[1] In accordance with the laws of simplicity and economy of effort, the flexibility of some parts of the vocal apparatus far exceeds the rate of any other voluntary act.

cept this limitation and our experiments throughout show that fatigue lets the unconscious work, *i. e.*, it lessens distraction, permits a freer distribution of attention. If fresh we had more force available than laboratory experiments required and the inevitable overflow came to light in spurty tensions and frequent responses to irrelevant matters. Too great strain entailed a cramp that prevented some of the most customary associations in B, but these were made so soon as the strain eased (cf. Lalande and Paulhan). In the "unconscious" work noted above, a certain order seemed imperative. Factors in A had to be put in a habitual way; in C the bias, or constant error, defied our efforts at conscious control.

The usual muscular tensions that characterize or accompany concentration of attention, were well marked in all the experiments. Checked breathing, suspension of movements, a strain about eyes or ears, were common. In C the effort to hold an even hand between stimuli to organs of the same sense brought out clearly the great dependence of "balanced attention" on equilateral tensions. To be alert and yet neutral, *i. e.*, to be intentionally indifferent, it was necessary to fixate a point in the median plane and to have an equal distribution of tensions on each side of the body. The slightest deviation therefrom, if but a tendency to a side-movement of the eyes, was sufficient to make uncertain the judgment of the order in which the clicks came. As concentration is tension, it easily passes by overplus into distraction, or opposing tensions. In A uncalled fingers, and even the whole arm, made irrelevant reactions; in B the very effort for great attention defeated its aim; in C the order was easily lost when too much awaited. But attention is not only a matter of tension on its physical side. Without change concentration soon degenerated into stupor; all distractions soon dulled; in each case aid was got, both for concentration and for distraction, by shifting positions. The readjustment of tensions was conducive to distraction if the stimuli were received whilst the change was in progress, because the correct response was but one of many possible tensions; if the stimuli came when the tension-adjustment was just below its crest, they found favorable reception. To get the faint clicks in C, concentration (*i. e.*, suspension of motion) had to be very great; my custom was to draw a full breath and begin to expire just as the clicks were expected. The momentary balancing on the tension-crest enabled the clicks to come as if into the field of vision.

So inveterate (or normal) is the habit of association that it is practically impossible to get trace of an idea without giving it a space setting. Definite localization was all but general; those few cases wherein it failed may probably be explained as unscrutinized. In A the stimuli, coming from the operator, seemed to be external in nature; they and their responses were free from subjective control. In B and C the associations and sensations were projected, and their spatial distance was usually strongly felt. In B at times the consciousness of place was greater than that of the object felt to be there. In C if the focus, fixated in order to keep attention median, was distant, the stimuli were remote; if near by, the stimuli came near. The evident reason for these facts is that an idea rests on a complex, each element of which has its harmonious space-reaction. The nature of a complex idea (an object of thought composed of known elements) necessitates a play of tensions to give its full expression, and full presence as well. Put into terms of an inner activity this kaleidoscopic play may be formulated in: Ranging is necessary for fruitful attention, *i. e.*, in order to get many associates. Mere attention, considered as fixation, lands the mind in

blankness. The fact noted above, that some distraction is an aid to work, finds an inner correlate in the need of "ground-wires" to draw off the excess of energy. The non-attended incidents and possible stimuli about us (for concrete, though extreme, stock-cases, take the button of Scott's class-mate, Schiller's rotten apples, the uproar of the mill) are the background on which we project and estimate our heeded experiences.

Spatial readjustment of our mental stock was often a very conscious and troublesome process. Thus, in A difficult problems were analyzed and solved piece-meal on the lines of least resistance; in B perplexing key-words were dismembered and referred to their root-origins; in C the sensations were commonly translated into objective figures. In B it was necessary to arrange the associations in groups in order to retain them; in C the time order had to be decided by an immediate impulse, else would consideration drive out the possibility of decision. Our experience in C indicates that judgment of time order depends on one's interpretation of his space-experiences. Space to us is largely a matter of projection, and with normal persons this is in terms of sight (cf. Wundt, 1, II, 121-2). So long as the subject in C was fresh and passive, the time order of the stimuli was well perceived; certainty was greatest when there was least conscious effort to decide. Quite otherwise was the matter when for any reason, fatigue or wandering mind and shifting tensions, the order was obscure. In the latter cases decisions, as noted above, wavered between feeling and judgment, *i. e.*, between the impulsive and the conscious. Yet when these opposing claims were examined, I could not see there was anything else to motive them than differences of perceived intensity. My impression is that in the immediate, sensory form the body-state was in a condition of alert indifference; that in the "feeling" form the body-state was one of change, but that the stimulus-tension got and retained a relatively stable condition which, in time, often sufficed to gain it notice. In the last named form one wonders if he started from the stimulus and went to the related ideas, or from these latter over to the idea about the stimulus. But as has been said, when the immediacy of the struggle, the basal feeling of the sensation, was gone, the case was rejected. It should be remembered, however, that these uncertain cases were but a fraction of the series; often subjects gave correctly the order of nearly entire sets (twenty trials each), and were sure of their answers. The doubtful cases bring out the fact that the stimuli were known as unequal; of this, more later.

A constant error, rather a general bias, has been noted in the experiments of the third part. It was easier to decide for one side than for the other, as was shown by the preponderance of correct answers on the favored side, due, probably, not to better perception, but to an excess of answers in one direction. This is akin to habit, perception of the probable, apperception ruts, and, I believe, is related to certain fixed muscle adjustments. For S. and D. this constant error has been shown in Table 4, and in 13 is shown the result of shifting body conditions with intent to redistribute tensions. Although various subjects knew of this failing and endeavored to guard against it, the undertow was too strong to be resisted. At times the bias was maintained, although the intensities of the stimuli were made to differ considerably; now and then the error would change from one side to the other, but in the long run it was fairly constant. Because of this bias, experimentation with some subjects was given up.

Here may be noted the observation that organs of the same sense

receive like stimuli in unlike ways. Differences in the abilities of the eyes and of the ears are well known; analogous is the case of the hands. For a time it was possible to judge the order of shocks in C by these qualitative differences in sensation. There was needed a certain degree of intensity in order to arouse these sensation-forms; below the minimal quantity quality failed to appear. In the case of the very faint clicks this loss of quality was very great. At the outset and for some time thereafter, these were projected on a level with and a trifle back of the shoulders; they were seen, with the eye of imagination, as whitish spots on black backgrounds, like the pictures that represent stars in constellations in astronomical text-books. As intensity increased the clicks became more like experiences known as sound, and so came up toward and into the ears. Yet, unless the subject was in good responsive condition, at the short interval ($.024\sigma$), with increased intensity the clicks would overlap, either in a confused sound, or as overlapping auroral flashes, in terms of sight, and before the face. When the clicks were really simultaneous, they were perceived as one located in the occipital part of the brain. In every case as intensity grew, the clicks approached each other; due, probably, to the fact that the tension responses were greater, and so intermixed. Bolton (p. 228) notes, "The strongest sound seemed longer than the rest;" because its effect, more widely diffused, aroused the idea of extension.

It was our custom in C to interchange the battery connections, whereby the stimulus that had gone to one side should be sent an equal number of times to the opposite side; by so doing we sought to neutralize any lurking inequalities. But one day, while using shocks with indifferent attention, we crossed our arms and thus received the right hand shock in the left hand, the shock from the left side in the right hand (cf. p. 550). To our surprise the stimulus in one hand would at times entirely disappear, and when felt was much weaker than its mate. That the objective intensities were unchanged we proved by tests; that the trouble was not a local defect was shown by the fact that at times a plain after-sensation of the shock could be felt in the fingers, though the original sensation had escaped detection. On some days the loss of the shock was especially common in one hand; at other times the opposite hand so suffered; while on yet other days the loss shifted back and forth. Knowing that both shocks were given and of like intensity, one could not avoid watching for a sensation on the perplexing side; but expectant attention in this case was not equal to sensation, although often it was impossible to decide whether a faint trace of the missing sensation had been felt or imagined. These cases seem to be veritable cramps of attention. In one series, designed to get twenty judgments, after nine had been given, I had twenty-one trials on the tenth before making a (guess) judgment. Here shifting one's position did not aid perception. After the eighth trial I walked about to shake off the cramp; after the tenth trial the left cup (by which no sensation had been aroused) was tested and its stimulus found to be working normally. In this case the trouble, though present in a few early cases, did not become set until the series was half done. Another day the cramp began at the outset, and forty trials were made before a judgment could be given; in the final trial the stimuli were plainly felt in both hands, and in their order; in every trial the stimuli had been sent and in changing order. Thirty of the trials were made with right hand above, the remainder with left above. In the thirty-second trial the right-hand shock was missing; in the others of this set the trouble was

with the left side. Not that the left stimulus was always entirely absent. In this particular set my notes show six times when the left *seemed* to lead, although the only stimulus "known" was felt on right; each of the six was a case of left first. When the bias to one side (and especially to the right) was strong, the shocks on the left became dissociated from the fingers, and commonly settled in or near the median plane, at the crossing point of the arms.[1] Two naïve subjects who were used to test this matter, found the median plane tangle; but, introspecting less, and less anxious for exactest judgments, they did not stick on the dead centre, but guessed themselves out of the difficulty. That the trouble was not in the apparatus was certain. The stimuli were given by the break, which gave a stronger shock than the make. In a troublesome run, in which one side repeatedly failed to take part, a slight delay in removing the hands from the cups enabled me to feel the make. So unexpected was this that, despite its real faintness, it startled me far more than had the regular stimulus.

If the non-appearance of the stimulus noted above be due to an attention-cramp, it may be asked to which side attention was given. As a rule it is next to impossible for one designedly so to control his attention as to become oblivious to surrounding stimuli; the very effort to turn away from a stimulus often puts its claim more forcibly. So, too, it was practically impossible for one to fail to perceive an awaited stimulus without becoming disposed to be alert for its coming; yet the positive and strenuous direction of attention actually did less to facilitate perception than did a state of indifference. In general the shocks in the side to which attention was given were felt as being much weaker than those in the unattended side,—doubtless because the strain diffused until it cramped the mobile parts needed to receive the expected shock. This fore-tension explains in part why "not even shock affects the muscular form of reaction," for not only is the shock's work begun, but once begun, the probability of diversion is lessened. In a sense it may be said, "Expectant attention and sensation [are] identical processes." (James, I, p. 429). In the case noted above the tension in the attended hand was as great as, or greater than, that produced by the shock, hence the latter was felt little or not at all. In the other hand the contrast between the relaxed and the contracted conditions gave a good example of passive attention, with a difference of states so great as to compel regard. Hence in this experiment serial order was often upset, because at times the only shock-tension experienced was in the non-attended hand, and this was heeded because the only other mental rival was the consciousness of a cramp. In truth the latter was no rival. Treating the hands as disparate senses, the case was akin to our common experiences wherein we refuse response to so-called distractions. Again it may be said a certain amount of distraction facilitates perception, in that it prevents this overflow of tensions (compare Urbantschitsch and Münsterberg, 4). "Distractions" need to be further differentiated, since they may be more attractive and absorbing than one's set task, and so fill his mind; or they may be suggestive of varied associates and so make concentration all but impossible.

It may be objected that the illustrations given of cramped attention are all exclusively physiological, and the extension of inferences therefrom to ideas questioned. But quite similar were the experiences in B—association. While adding for distraction, it was

[1] Compare "An Experimental Study of Simultaneous Stimulations of the Sense of Touch," W. O. Krohn, *Journal of Nervous and Mental Diseases*, March, 1893.

much easier to have "knowledge-about," *i. e.*, to broadly survey, one's addition, general feeling, flight of time, progress of the experiment, and the like,than it was to attend to the key-words. The effort to hold fast the word bred stupor, gave cramp; the tensions corresponding to the work of addition, one's acts, etc., were in continual change. Whole sections of common thought were often left untouched during the time allotted for association.

In any discussion of Attention we need to consider first the name, for it is a word that includes in its various meanings all mind action—passive and active,—and because of this range its explanatory value is but a pretence. Leaving aside the fact that consciousness is active *per se*, the attention that we know is a resultant of tensions, *i. e.*, an element in knowing and so is present in all states of mind. What the motive power back of this tension is, we do not know; but nothing is gained by giving it a name of ignorance and then subdividing this X into active and passive forms. We feel mind action to be passive when aroused chiefly by sensory means (and these include a large part of the suggestions that motive idle revery); active when aroused by ideo-motor means. In the former we find ourselves in an attentive state because of the impulsive response of sense-organ adjustments; these in cases, *e. g.*, iris and lens, go on out of mind. In the latter the kinæsthetic idea is necessarily in mind before its sequent steps are aroused, and the mind, prevising, feels its initiative. In either case attention as a psychic state follows and depends on tensions.

The study noted in these pages was carried on under the general direction and with the constant aid and counsel of Dr. E. C. Sanford, to whom my thanks are due in large measure; however, he is no way responsible for the short-comings. To President G. Stanley Hall for stimulating suggestions and insights that rouse one to new views, and to Dr. W. H. Burnham for sympathetic criticism and assistance all along the way,—I wish especially to acknowledge my obligation. Nor would I omit to recognize my debt to Mr. Jonas G. Clark, to whose generosity is due the facilities so abundantly furnished for my work. It is a privilege to thus express my indebtedness to these men, for, because of them, the work was made a pleasure.

V.

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NOTE.

While Mr. Drew's experiments on Association were in progress, I undertook a similar series in order to check his results by those of a second observer. The method used was not quite the same, the most important difference being a greater freedom of association on my part, *i. e.*, each association was not held strictly to the original stimulus word. The nature of the data gathered in such experiments makes it almost indispensable that each observer should work up his own results, and this I have not found time to do, with sufficient completeness for exact tabular presentation. I venture, however, to give here such general statements as a rather full preliminary examination seems to justify.

In the first place my lists, like those of Drew, show little difference in the fertility of association between those series in which addition was performed and those in which attention was left free. This unexpected result may depend, as he suggests, on an unintended distraction, introduced by the knowledge that the time for getting associations was limited, or on the fact that in most cases there was not thorough absorption in the adding, the associations being secured at intervals of slight neglect of the means of distraction. Another effect of the adding is apparent in my case, however, in the greater number of cases in which wholly extraneous ideas entered, or in which an association once glimpsed was lost in whole or in part before the time came for recording. The subjective feeling of greater irksomeness also distinguished the tests accompanied by addition, and introspection seemed more difficult.

The most marked qualitative difference between the series with adding and those without is a clear preponderance in the latter case of associated phrases (quotations and the like). A similar relation, though quantitatively much less, appears in Drew's table F, where the percentage of "word" associations is greater in the series with full attention. This difference may be caused by the need of at least a partial functioning of the language apparatus, central and peripheral, in the adding (cf. the article of Theodate Smith above).

As with Drew and other experimenters by this method, a considerable number of associations noted in the first trial with each series recurred again in the second trial, but the distribution of repetitions among the series is different in my case from Drew's, the series in which adding was used in both trials standing out alone with a decidedly higher proportion of repetitions than the rest.

Of Drew's observations during the course of the experiment, several were very frequently confirmed in my series, most strikingly of all the tendency to internal speech and to the immediate spatial location of the associations started. The very first thing that could be observed in most cases, after the method of work had become familiar and the operator practiced in introspection, was a mental pronunciation of the stimulus word, and a verbal accompaniment was also found with many of the succeeding associations. The tendency to locate followed immediately upon the recognition of the stimulus word, or possibly as a part of its recognition. At times it served as a sort of algebraic symbol, and took the place of a more tardy but fuller image in visual or other terms. It was often a kind of mental pointing, an unformed "that thing, there." No classification according to period of life was attempted in my case.

E. C. SANFORD.